Forest Health Protection

Pacific Southwest Region

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To: Rick Larson, District Ranger, Kern River RD, Sequoia National Forest

Subject: Insect and Disease Evaluation of the Kern River and Greenhorn Ranger Districts (FHP Report SS07-04)

At the request of Pat Dauwalder, Timber Sale Administrator, Kern River Ranger District, Sequoia NF, Danny Cluck, entomologist, and Martin MacKenzie, plant pathologist, conducted a field evaluation of portions of the Kern River and Greenhorn Ranger Districts on August 2 and 3, 2007. The objective of this visit was to evaluate bark beetle activity occurring within and adjacent to the 2002 McNally Fire and within the Troy Meadow Campground and to evaluate the potential for future bark beetle caused tree mortality. In addition, declining sugar pines were visited on Greenhorn Summit of the Greenhorn Ranger District and several other insects and diseases were identified and discussed as encountered during the field trip. Management alternatives and recommendations were discussed among the participants and will be highlighted in this report. These recommendations will assist with the identification and development of future vegetation management plans on these Districts and the rest of the Forest. Pat Dauwalder, Brian Bergman, Brenda Ehmann, Sue Porter, and John Goumez from the Kern River RD and Steve Hanna and Jim Whitfield from the Supervisor's Office accompanied us to the field.

Background

The 2002 McNally Fire and the Troy Meadow Campground are located on the Kern River Ranger District northeast of the town of Kernville, CA. Greenhorn Summit is on the Greenhorn Ranger District west of Kernville. Elevation ranges from 4000 to 10000 feet with the lower conifer tree line occurring at around 6000 feet. Annual precipitation for the area is approximately 20 - 25 inches at the lower elevations and on the eastside of Sherman Pass and up to 35 inches on Greenhorn Summit. The forest ranges from Sierra Nevada mixed conifer on the westside consisting of Jeffrey pine (*Pinus jeffreyi*), ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*), incense cedar (*Libocedrus decurrens*), Douglas-fir (*Psuedotsuga menziesii*), sugar pine (*Pinus lambertiana*) and black oak (*Quercus kellogii*) to more of an eastside mixed conifer type on the eastside of Sherman Pass consisting mostly of Jeffrey pine (*Pinus jeffreyi*) and white fir (*Abies concolor*). Red fir (*Abies magnifica*) and western white pine (*Pinus*

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monticola) occur at the higher elevations and lodgepole pine (*Pinus contorta var. murrayana*) is found in most upper elevation drainages and meadows. Management objectives include the need to prioritize areas for potential vegetation treatments and to identify and plan for specific disturbance agents such as insects, disease and fire that may negatively influence desired future conditions.

Observations

Numerous Jeffrey pines located within the 2002 McNally Fire have recently faded as a result of Jeffrey pine beetle (*Dendroctonus jeffreyi*) attacks sustained in the fall of 2006 and spring/summer 2007. Most of the affected trees sustained moderate to high levels of injury to their crowns and/or cambium during the fire. Mortality was also observed in areas away from the McNally Fire but to a lesser degree. Many green crowned trees have new bark beetle attacks as evidenced by the presence of reddish pitch tubes. These green infested trees were mostly found next to recently faded trees.

Conks associated with annosus root disease (*Heterobasidion annosum*) were found within an old Jeffrey pine stump on the eastside of Sherman Pass near a small pocket of Jeffrey pine mortality. These trees were being attacked by the Jeffrey pine beetle. Despite this find, there is little evidence of a significant annosus root rot problem in most Jeffrey pine stands in the area.

Mountain pine beetle (*Dendroctonus ponderosae*) is attacking and killing western white pine near the top of Sherman Pass and Sherman Peak and lodgepole pine in and around Troy Meadows Campground.

Several sugar pine in the Greenhorn Summit area are suffering from defoliation likely caused by the fungus (*Lophodermella arcuata*), also known as sugar pine needle cast. What little foliage these trees have left is also being attacked by the black pineleaf scale (*Nuculaspis californica*). The fungus appears to have subsided at least a year ago as new healthy foliage is apparent on all branch tips (Figure 1). The scales were observed on current year needles (Figure 2).

Figure 1. Recovering sugar pines with new healthy foliage at branch tips.

Figure 2. Current year needles with black pineleaf scale.

Sugar pine dwarf mistletoe (*Arceuthobium californicum*) was observed in a couple of sugar pines on Greenhorn Summit.

White fir mistletoe (*Phoradendron densum*) was observed in the tops of many large white firs on Greenhorn Summit.

Cytospora canker (*Cytospora abietis*) combined with true fir dwarf mistletoe (*Arceuthobium abietinum* f.sp. *magnificae*) is causing branch dieback on red fir on Sherman Pass and areas near the Black Rock Work Station. Scattered red fir and white fir mortality was observed throughout the Kern River RD and is likely the result of attacks by the fir engraver beetle (*Scolytus ventralis*) and/or round headed woodborers (family: Cerambycidae) combined with *Cytospora*, dwarf mistletoe, annosus root disease (*Heterobasidion annosum*) and the current dry conditions.

Elytroderma disease (*Elytroderma deformans*) was observed on Jeffrey pine near the Corral Loop Road trail, causing branch brooming and reduced foliage growth.

Western dwarf mistletoe (*Arceuthobium campylopodum*) was observed in Jeffrey pine at the Black Rock Work Station.

Branch flagging and limb and bole cankers caused by white pine blister rust (*Cronartium ribicola*) were observed in many sugar pines on the westside of the Greenhorn summit. Evidence of mountain pine beetle activity was apparent in recently killed trees that had high levels of rust infection.

Discussion and Recommendations

Many of the forested areas of the Sequoia National Forest are typical for Sierra Nevada and eastside mixed conifer stands that have had fire excluded for 100+ years; high accumulations of fuels, dramatic increases in stand density (mostly dense understories and mid-stories made up of shade tolerant species such as incense cedar and red and white fir), mortality occurring from insects and disease, primarily in the larger trees, and limited regeneration of shade intolerant tree species such as western white, ponderosa and Jeffrey pine. Lodgepole stands have also reach maturity in these 100+ years making them highly susceptible to bark beetle attacks.

The Forest should consider the potential negative impacts of insects, disease, drought and fire in high density stands. Failure to reduce this density through thinning and/or prescribed fire will allow the older and more decadent pines and true firs to continue to succumb to various pathogens and bark beetles. Stand density will continue to increase over time, consisting mostly of small diameter incense cedar and red and white fir. These trees will grow slowly due to increased competition and in some areas, will be at risk to infection by annosus root disease, spread by adjacent infected stumps and live and dead trees, and infection by dwarf mistletoe, spread by adjacent infected overstory trees. Pine species will occupy an even smaller percentage of the stands due to limited regeneration and mortality of mature trees. High levels of tree mortality, for all size classes and species, caused by bark beetle attacks can be expected during extended periods of below normal precipitation. High stand density and drought triggered tree mortality will continue to increase fuel loading, thus creating a higher risk of stand replacing wildfire. All of these conditions and trends will not likely lead to healthy and resilient forests over the long term.

Most stands would benefit by the removal of severely diseased trees and an overall reduction in stand density. Most stands within the Sierra Nevada range should have their density reduced to somewhere between 50 – 60 % of the maximum stand density index (SDI) for the site to

minimize the impacts of drought, fire, insects and disease. Thinning treatments should also be consistent with recent direction from the Regional Forester that suggests designing thinnings to "ensure that density does not exceed an upper limit (for example: 90% of normal basal area, or 60% of maximum stand density index)" and to "design thinnings to ensure that this level will not be reached again for at least 20 years after thinning." (Regional Forester letter, "Conifer Forest Density Management for Multiple Objectives", July 14, 2004). However, some areas within the Sequoia NF will require the maintenance of high canopy closure levels for wildlife, resulting in higher stand densities than the recommended upper limit. If canopy cover requirements do not allow for a reduction in stand density that increases the health and vigor of residual trees, the risk for bark beetle caused mortality will remain, especially during prolonged periods of drought. Failure to reduce the risk of successful bark beetle attacks could result in significant mortality and reduce the habitat suitability for some wildlife species.

When planning thinning treatments, it should be recognized that the target stand density is an average to be applied across the landscape and some variability may be desired. Individual high value trees, such as mature pines, should benefit by having the stocking around them reduced to lower levels. Areas of pure or nearly pure Jeffrey, ponderosa and lodgepole pine would also benefit from lower stocking levels as well as an increase in species diversity (where alternate species occur). Allowing for denser tree spacing and pockets of higher canopy cover may be desirable for wildlife habitat, such as around potential nest trees (fork-topped trees or larger ponderosa pines that have dwarf mistletoe brooms). When implementing thinning projects, retaining more drought tolerant species such as ponderosa and Jeffrey pine, sugar pine and incense cedar over white fir will increase species diversity and make the stand more resilient to disturbance agents such as insects, disease, and fire. In addition, when selecting trees for removal, preference should be given to trees heavily infected with dwarf mistletoe, root disease and trees infested with bark beetles. Small group selections should be utilized to remove root disease pockets and clumps of trees with heavy dwarf mistletoe infections. For all thinning operations, it is recommended that a registered borate compound be applied to all freshly cut conifer stumps >14" dbh in order to reduce the chance of new infection centers being created through harvest activity. However, the treatment of white fir stumps may not be necessary if stands already have a high level of "S-type" annosus infection (Appendix A).

When thinning trees where annosus root disease is present, it is beneficial to create a mix of tree species and sizes while limiting the number of susceptible hosts (true fir in the case of the S-type and pines in the case of the P-type, Appendix A). For root diseases, it is reasonable to use the condition of the crown as an indicator of advanced decay. Although not always caused by root decay, a thin crown does indicate poor tree vigor. A tree with reduced photosynthesis is not able to maintain healthy roots as well as a tree with a full and healthy crown. In the presence of root disease, unhealthy roots will likely be overcome with decay faster than vigorously growing roots. For this reason, the thinner the crown of a tree in an area where root disease is present, the more likely it is that the roots have been weakened by decay.

Special consideration needs to be given to western white and sugar pine. White pine blister rust, a non-native pathogen, has continued to weaken and kill these species over most of their range since its introduction into the Pacific Northwest in 1910. Identification and protection of local rust resistant trees for seed collection, if not already occurring, will aid in the future planting of rust resistant seedlings. Planting selected openings created through thinning operations with rust resistant stock would help ensure this species persists in the area.

White pine blister rust (WPBR) was first detected on the Sequoia NF in 1970 on the Greenhorn RD and later near Breckenridge Mountain in 2002. This southern most tip of the Sierra Nevada range marks the current southern extent of WPBR in California. Kliejunas and Adams (2003) reported in a *Tree Notes* publication that the rust intensified rapidly on the Sequoia NF after 1970 and that the rust in this area generally appears higher in the trees than in the Central and Northern Sierra Nevada. Photo documenting the intensification of WPBR within individual trees on the Greenhorn RD (Figure 3) and their decline over time could provide a valuable educational tool for the public. FHP Southern Sierra staff would be interested in working with the Forest in setting up photo points and developing educational materials for WPBR. This information would also be submitted for publication in the annual California Pest Conditions Report.

Figure 3. Branch flagging caused by WPBR infections.

Specific Recommendations for Recreation Areas

It is important to note that when implementing tree removal or hand thinning in a recreational site, Region 5 direction calls for the treatment of all conifer stumps with a registered borate compound to reduce the probability of infection by annosus root disease. Care also needs to be taken to minimize soil compaction and the wounding of residual trees.

To prevent mountain pine beetle related tree mortality in the short-term at the Troy Meadows CG a couple of management options exist; 1) direct control through the removal of green infested lodgepole pine and 2) applications of insecticides to un-infested tree boles. Although there is no general agreement regarding the effectiveness of direct control of mountain pine beetle, some success has been observed in Donner Camp, Tahoe National Forest; which was also a relatively isolated outbreak in a smaller lodgepole pine stand. To implement this management option, green infested lodgepole pine must be identified and removed promptly. This would require annual or bi-annual tree inspections and subsequent removal of infested material prior to beetle emergence. The second short-term preventative measure would be the use of insecticides on tree boles and would require the development of a campground vegetation management plan in order to use a categorical exclusion for treatments. All non-infested trees greater than 8” DBH in the campgrounds would be treated with a registered pesticide (either a carbaryl or permethrin product) by spraying as much of the bole as possible. If there are many trees less than 8” DBH making up the majority of the campground stand, the District should also consider spraying a portion of these. Trees would need to be treated prior to mid-May 2008, before the first beetle flight, to be effective (preferably this fall). Insecticide treatments can provide protection up to two years against bark beetle attacks giving the District time to develop and implement long-term strategies to reduce overall tree susceptibility. Consideration needs to be given to the choice of insecticide since the campground is in close proximity to water.

Despite the effectiveness of any long or short-term plans to prevent tree mortality, some trees, through declining health, will eventually become hazards to the public. To minimize the risks associated with hazard trees, they should be identified and removed before they fail. The current practice for many National Forest is to remove trees as they die. This eliminates the risk from dead trees but fails to address living trees that are infected with root disease, heart rot, and/or have a structural defect. These high-risk green trees are equally hazardous and should not be overlooked. Therefore, it is recommended that the District develop a hazard tree evaluation and monitoring plan for their recreation areas. At your request, Forest Health Protection can provided information and assist with the development of this plan. In the short-term, trees within recreation areas that have obvious stem decay, dead tops and/or large dead branches should be carefully evaluated and hazards removed or pruned as soon as possible

Monitoring and Marketing Forest Health

The Sequoia NF is a high profile forest that receives extra scrutiny from the public in all of its management activities. This high level of public involvement increases the complexity of implementing any vegetation management project and often results in fewer treated acres. In most Sierra Nevada National Forests, a lack of understanding by the public regarding forest stand dynamics, the role of fire in the ecosystem and the impacts of insects, disease and drought on forest health prevents them from supporting vegetation management projects. The Forest Service could improve on public information and education regarding the need for such activities and the consequences of a no management alternative. To address this need, FHP can assist the Forest in setting up small scale monitoring projects to follow stand treatments over time and document the impacts of insects and disease in treated versus untreated stands. This type of information could be used in public displays within the forest, in the development of public information flyers and brochures and within NEPA documents to support the need for vegetation treatments. FHP also encourages the Forest to report and photograph any insect and disease activity to the Southern Sierra Service Area staff so it can be included in the annual California Pest Conditions report. This report will be made available to the Forest and to the public to further highlight forest health issues.

Forest Health Protection may be able to assist with funding for thinning and removing green material from overstocked areas on the Sequoia NF through the Western Bark Beetle Initiative program. If you are interested in this funding please contact the Southern Sierra Forest Health Protection staff for assistance in developing and submitting a proposal.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431 or Martin MacKenzie at 209-532-3671 ext 242.

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Appendix A – Insect and Disease Information

Jeffrey Pine Beetle

The Jeffrey pine beetle is the principle bark beetle found attacking Jeffrey pine, which is its only host. It is a native insect occurring from southwestern Oregon southward through California and western Nevada to northern Mexico. The beetle normally breeds in slow-growing, stressed trees. The beetles prefer trees which are large, mature, and occur singly rather than in groups. Yet when an epidemic occurs, the beetle may attack and kill groups of trees greater than 8 inches in diameter, regardless of age or vigor. Often the beetle infests lightning-struck or wind-thrown trees, but does not breed in slash.

Evidence of Attack

Presence of the beetle is usually detected when the foliage changes color. The color change of the foliage is related to the destruction of the cambium layer by the beetle. Generally, the top of the crown begins to fade in a slow sequence, with the needles turning from greenish yellow, to sorrel, and finally to reddish brown. By the time the tree is reddish brown, the beetles have usually abandoned the tree. Another sign of beetle attack is large, reddish pitch tubes projecting from the bark of the infested tree. If examined carefully, pitch tubes can be detected on infested green trees prior to crown fade. Jeffrey pine beetles have a distinctive "J" shape egg gallery pattern on the inner bark. Larval mines extend across the grain and end in open, oval-shaped pupal cells.

Life Stages and Development

The Jeffrey pine beetle is one of the larger pine bark beetles in California. The beetle has a 4 life stages, egg, larva, pupa, and adult. The adults are stout, cylindrical, black, and approximately five-sixteenths of an inch long when mature. The egg is oval and pearly-white. The larva is white, legless, and has a yellow head. The pupa is also white but is slightly smaller than the mature larva. The life cycle is normally completed in one year in the northern part of the range, but in the southern part, two generations per year may occur. The principle period of attack is in June and July, but attacks also are frequent in late September and early October. Similar to other Dendroctonus species, Jeffrey pine beetles use pheromones that attract other beetles to a tree, causing a mass attack that tends to overcome the tree's natural resistance. Blue stain fungi are associated with Jeffrey pine beetle attacks and aid in overcoming the tree’s defenses.

Conditions Affecting Outbreaks

Normally the Jeffrey pine beetle is kept in check by its natural enemies, climatic factors and the resistance of its host. Similar to other Dendroctonus species, the availability of suitable host material is a key factor influencing outbreaks. Healthy trees ordinarily produce abundant amounts of resin, which pitches out attacking beetles. When deprived of moisture, or stressed by other factors such as disease or fire injury, trees cannot produce sufficient resin flow and become susceptible to successful beetle attacks.

Mountain pine beetle

The mountain pine beetle, *Dendroctonus ponderosae,* attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. In addition to pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Attacking beetles carry the spores of blue-staining fungi which develop and spread throughout the sapwood interrupting the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the needles to discolor and the tree to die.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is typical, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long, vertical, egg galleries and lay eggs in niches along the sides of the gallery. The larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Conditions Affecting Outbreaks

The food supply regulates populations of the beetle. In lodgepole pine, it appears that the beetles select larger trees with thick phloem, however the relationship between beetle populations and phloem thickness in other hosts has not been established. A copious pitch flow from the pines can prevent successful attack. The number of beetles, the characteristics of the tree, and the weather affect the tree's ability to produce enough resin to resist attack. Other factors affecting the abundance of the mountain pine beetle include nematodes, woodpeckers, and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases and pine mortality increases.

Red Turpentine Beetle

The red turpentine beetle, Dendroctonus valens, occurs throughout California and can breed in all species of pines. It normally attacks injured, weakened or dying trees and freshly cut stumps. The adults are attracted by fresh pine resin. They often attack wounded trees in campgrounds or following logging, trees scorched by wildfire or prescribed burns, lightning-struck trees and root-diseased trees exhibiting resinosis.

Attacks usually occur at the soil line or root crown and are characterized by a large reddish pitch tube at the point of entry. On severely stressed trees or during periods of drought, attacks may occur underground on the main roots up to 15 feet from the bole and also on the bole to a height of 10 feet. If an attack is successful, the adults excavate an irregular gallery in the cambium and the female lays eggs along the sides. The larvae feed in a mass and destroy an area of cambium ranging from 0.1 to 1.0 square feet. Attacks do not always kill trees but may predispose them to attack by other bark beetles. Repeated or extensive attacks by the red turpentine beetle can kill pines.

Attacks occur throughout warm weather and peak at mid-summer. The number of generations varies from two years for a single generation at the coldest portions of its range to two or three per year in the warmest.

Attacks can be minimized or prevented by avoiding soil compaction and injury to standing trees during logging or construction and also by insecticide application to high value trees.

Annosus Root Disease

Heterobasidion annosum is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (*Arbutus menziesii*), and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Annosus root disease is one of the most important conifer diseases in Region 5. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and depletion of vegetative cover and increased probability of tree failure and hazard in recreation areas.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds, or occasionally, through roots of stumps in the absence of surface colonization. From the infected stump surface, the fungus grows down into the roots and then spreads via root-to-root contact to adjacent live trees, resulting in the formation of large disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of *H. annosum* have major differences in host specificity. All isolates of *H. annosum* from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita have, to date, been of the 'P' group. Isolates from true fir and giant sequoia have been of the "S" group. This host specificity is not apparent in isolates from stumps; with the 'S' group being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Dwarf Mistletoe

Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains

throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionaly vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of gray pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.